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INTRODUCTION

Anthracnose, known also as spadix rot or black nose, continues to be the most serious disease of anthurium in Hawaii. It is caused by the fungus *Colletotrichum gloeosporioides* and is particularly severe in high-rainfall areas on the island of Hawaii (*1*, *2*). Anthracnose has been observed on Oahu, but to date it has been sporadic in occurrence. There is no record of the disease on Maui or Kauai.

The disease can be readily controlled by applications of maneb (*1*, *2*). However, this control measure is not widely practiced because many growers object to the residue visible on flowers from maneb applications. An alternative to fungicidal spray applications is growing disease-resistant cultivars.

Several anthurium cultivars are grown commercially for the cut-flower trade. Among the most popular are Kaumana, Kozuhara, and Kansako No. 1, but these are highly susceptible to spadix rot in the field. Also popular popular are Ozaki and Nitta Orange, which are moderately resistant to the disease. Abe Pink and Kansako No. 2 have been recognized by growers to be highly resistant. These have remained virtually free from the disease even under conditions that are very favorable to anthracnose development. Unfortunately they do not combine the desirable horticultural characteristics of the popular but susceptible cultivars.

There is an obvious need for anthurium cultivars that are esthetically acceptable, highly productive, and resistant to anthracnose. Since it was apparent that genetic variation in resistance and susceptibility to anthracnose exists among cultivated anthuriums in Hawaii, anthracnose resistance was included as one of the principal objectives of the anthurium breeding program at the University of Hawaii.

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After developing a suitable technique for testing pathogenicity of *C. gloeosporioides* on anthurium spadices, commercial cultivars, accessions, and advanced seedling selections were evaluated for disease reaction. Results to date, reported here, should be of particular interest to commercial growers in East Hawaii.

MATERIALS AND METHODS

Kaumana, one of the most popular commercial cultivars, was selected as the susceptible control. Kaumana spadix was observed to be most susceptible when the color change had progressed to approximately one-half the spadix length. Therefore a similar stage of maturity was selected for testing all cultivars and selections. Available flowers were harvested weekly and inoculations were made within an hour after harvest.

Several isolates of *C. gloesporioides* obtained from spadix rot specimens were tested for pathogenicity. One of these, a single-spored isolate designated as culture no. 42 and found to be virulent with a capacity for high sporulation, was selected as the test organism. Spore suspensions were made from 4-day-old cultures. Inoculum concentration was adjusted by diluting the orange colored spore suspension until the color extinction point was approached. By using this method, spore concentrations in the range of $1.2\text{-}6.4 \times 10^6$ spores/ml were obtained. The spore suspensions were made up in 1:2,000 Tween 20 solutions and sprayed with a hand atomizer. The anthurium spadices were completely covered and immediately incubated in plastic moist chambers for 24 hours. Initially the incubation temperatures were maintained at 22 to 27°C (72 to 80°F) but subsequently 30°C (86°F) was found to provide a more severe test. Following the infection-incubation period of 24 hours, the spadices were removed from the moist chamber; subsequent disease development took place in the laboratory without any environmental controls. Disease ratings were made 6 days after inoculations according to the following scheme: no infections = 0, 1 to 10 spots = 1, 11 to 50 spots = 2, more than 50 spots = 3.

RESULTS AND DISCUSSIONS

Responses of different cultivars are summarized in Table 1. Infection incubation at 25°C for 24 hours satisfactorily separated the anthurium cultivars into three major groups according to resistance. There were no escapes among the 123 Kaumana spadices tested at this temperature; however, 7 were in the 1 class, which represents a very low level of infection. Upon incubating at 30°C during the 24-hour infection period, the average numerical rating for Kaumana increased from 2.4 to 2.8; furthermore, of the 112 spadices, none were in the 0 or 1 classes.

Table 1. Anthracnose resistance of anthurium cultivars

Cultivar	24-hour 25°C infection incubation		24-hour 30°C infection incubation	
	Number Spadices	Average* Rating	Number Spadices	Average* Rating
Susceptible				
Kaumana	123	2.4	112	2.8
Kansako No. 1	21	3.0		
Kozuhara	4	2.8		
Kimura	2	2.5		
Ozaki	1	3.0	2	3.0
Ozaki Pink	3	3.0	1	3.0
Sunburst	4	3.0	2	2.5
Suyehiro	3	2.7		
Intermediate				
Nitta	67	1.8	5	2.0
Haga White	7	1.4		
Kanda Pink	8	0.9	5	2.0
Toyama No. 3	4	0.8		
Uniwai	9	1.8	4	2.5
Asato	1	3.0	2	3.0
Okamoto Orange	6	0.8	2	1.5
Resistant				
Abe Pink	6	0.2	7	0.3
Kansako No. 2	10	0.3	8	0.0
Marian Seefurth	15	0.0	5	0.0
DeWeese	12	0.3	2	0.0
Fukano	4	0.0	1	0.0
Hayashi No. 1	2	0.0		
Hayashi No. 2	5	0.6		

* 0=no infection; 1=1-10 spots; 2=11-50 spots; 3=more than 50 spots.

The average numerical rating was the primary basis for placing cultivars into the resistant, intermediate, or susceptible groups. Size of spots was a qualitative consideration for assessing disease resistance. Several cultivars in the intermediate group developed many tiny spots.

In general, these results conform with field observations made by growers, County Extension Agents, and ourselves. A conspicuous exception is Ozaki, noted to be anthracnose tolerant in the field but quite susceptible under our test conditions. Further investigations should clarify this discrepancy.

Marian Seefurth, recently released by the Department of Horticulture, University of Hawaii, is outstanding in its resistance. No infection was observed in 20 spadices tested. It compares favorably with Abe Pink and Kansako No. 2, two cultivars with proven field performance.

Uniwai, also recently released, is intermediate in disease reaction. Anthracnose will occur on this variety especially during warm, wet periods, but the disease on this cultivar can be more readily controlled by fungicide applications than anthracnose on highly susceptible cultivars.

In Table 2 reactions of recent accessions to anthracnose are presented. These accessions were received from various anthurium growers for evaluation at the University. Although sufficient time has not elapsed for adequate evaluation of yield and flower characteristics, the results on spadix resistance accumulated to date are of sufficient significance to be presented here.

Considerable variation in reaction from no infection to severe infection was observed among the accessions. These results should serve as a guide to growers intending to increase their stock. If anthuriums are to be cultivated in areas favorable to anthracnose, the grower should select and propagate only those that have a high degree of resistance.

University seedling selections tested for anthracnose resistance showed the results summarized in Table 3. Although variation in seedling resistance was observed as with the accessions, it is encouraging that there are many resistant selections. Among those that show high resistance are such promising selections as UH-139 (orange) and UH-185 (white), which are now being increased for release in the near future.

Table 2. Anthracnose resistance of recent anthurium accessions

			24-hour 25°C infection incubation		24-hour 30°C infection incubation	
Accession No.	Cultivar or Donor	Color of Spathe	No. Spadices	Avg.* Rating	No. Spadices	Avg.* Rating
A-120	K. Tanaka	Coral	1	1.0	1	2.0
A-121	T. Morinoue	Splash	1	0.0	1	2.0
A-124	Morimoto White	White	1	0.0	2	0.0
A-125	Nagai Orange	Orange	1	1.0	2	3.0
A-126	K. Toyama	Pink tinge	4	1.2	2	3.0
A-127	Nuuanu Pink	Dark pink	2	1.0	2	2.0
A-129	K. Toyama	Coral	1	3.0	2	3.0
A-130	K. Toyama	Splash	2	1.0	2	0.0
A-131	K. Toyama	Splash	1	0.0	1	0.0
A-133	K. Toyama	White	1	0.0	1	0.0
A-134	M. Shimabukuro	Splash	8	1.6	4	0.5
A-135	M. Shimabukuro	White	4	2.2	7	1.3
A-137	Y. Kuwahara	Coral	2	1.5	3	3.0
A-138	Nakazawa Red	Red	3	3.0	2	3.0
A-139	J. Kuwahara	Red			2	2.5
A-141	H. Hayashi	Red	2	2.0	1	3.0
A-143	Kaumana Brown	Brown	1	0.0	1	1.0
A-144	Hayashi White	White	1	1.0	1	3.0
A-146	Fuji Light Pink	Pink	2	0.0	2	0.0
A-147	Tsutsui Red	Red	2	3.0	1	3.0
A-150	M. Wold	Orange	3	0.3	3	0.0
A-152	T. Oishi	Red obake	2	1.5	1	3.0
A-153	C. Saito	Coral	2	1.5	2	3.0
A-154	Kaya Red	Red	2	2.5	1	3.0
A-155	Kohara Red	Red	2	3.0	1	3.0
A-159	Murayama Red	Red	1	0.0	1	0.0
A-161	K. Yee	Dark pink	1	2.0	1	1.0
A-167	Fujii Red	Red	1	2.0	3	2.7
A-168	Fujii Red	Red	4	1.0	2	3.0
A-176	C. Saito	Red			2	0.0
A-177	C. Saito	Red	2	0.0	3	0.0

* 0=no infection; 1=1-10 spots; 2=11-50 spots; 3=more than 50 spots.

Table 3. Anthracnose resistance of University seedling selections

Seedling No.	Color of Spathe	24-hour 25°C infection incubation: No. Spadices	24-hour 25°C infection incubation: Average* Rating	24-hour 30°C infection incubation: No. Spadices	24-hour 30°C infection incubation: Average* Rating
UH- 3	White	3	2.7		
UH- 4	White	6	2.7	4	2.8
UH- 8	White obake	12	0.1	10	0.1
UH- 9	White	2	0.5		
UH- 16	Pink obake	6	0.3	2	0.0
UH- 18	White	1	1.0	1	0.0
UH- 35	Orange	2	0.0		
UH- 39	Coral obake	7	0.6	1	0.0
UH- 46	Red obake	2	0.5		
UH- 64	Orange	2	3.0	1	3.0
UH- 69	Red	2	0.0		
UH- 84	White obake	4	0.0	4	0.0
UH- 86	Red	4	0.2	2	2.5
UH- 93	Orange	3	2.0		
UH-100	Red double	9	1.7		
UH-101	Red double	1	1.0	4	0.8
UH-103	Orange	5	2.8		
UH-110	Coral	4	0.0	1	1.0
UH-116	Red	2	0.0		
UH-120	Red			3	2.0
UH-139	Orange	3	0.0	3	0.0
UH-146	Orange			2	1.5
UH-149	Coral	1	2.0	1	3.0
UH-150	Red	4	0.8		
UH-151	Red	2	2.0	3	3.0
UH-154	Coral	5	2.4	2	3.0
UH-159	White	4	1.0		
UH-160	White	1	1.0	1	2.0
UH-163	Red	12	2.9		

* 0=no infection; 1=1-10 spots; 2=11-50 spots; 3=more than 50 spots.

Table 3 (Continued)

Seedling No.	Color of Spathe	24 hour 25°C infection incubation: No. Spadices	24 hour 25°C infection incubation: Average* Rating	24 hour 30°C infection incubation: No. Spadices	24 hour 30°C infection incubation: Average* Rating
UH-172	Orange	3	3.0		
UH-175	Red	4	0.2	1	0.0
UH-176	Red	2	0.0		
UH-184	Coral	1	3.0	1	0.0
UH-185	White	2	0.0	4	0.0
UH-186	Dark pink	2	0.0	2	0.0
UH-188	Coral	2	0.0	3	0.0
UH-190	Orange	1	0.0	1	0.0
UH-191	White	4	3.0		
UH-192	White	5	3.0		
UH-193	Orange			2	2.5
UH-194	Coral	1	0.0	1	0.0
UH-196	Coral	1	0.0	2	0.0
UH-201	Red	1	0.0	1	3.0
UH-203	Coral			2	2.0

* 0=no infection; 1=1-10 spots; 2=11-50 spots; 3=more than 50 spots.

SUMMARY

Studies of anthracnose resistance in anthurium have shown a wide variation in resistance and susceptibility. Marian Seefurth, Abe Pink, Kansako No. 2, and certain accessions have shown outstanding resistance. Promising University seedling selections with high resistance are UH-139 (orange spathe) and UH-185 (white spathe).

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